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Intercropping in Plantation Crops

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Intercropping, the cultivation of two or more crops together, enhances resources use efficiency and improves productivity compared to monocropping. It promotes better utilization of light, water, and nutrients, increased yield stability, and reduces pest and weed incidence. This system also supports soil health and provides economic benefits to farmers by minimizing risks. Overall, intercropping is a sustainable and practical approach for improving agricultural productivity, especially for smallholding farmers.

Introduction

Plantation crops such as tea, coconut, rubber, and oil palm occupy the same land for long durations, often spanning several decades. While these crops provide a steady income, the inter-row spaces, especially during the early years, are often underutilized. Intercropping refers to the practice of growing two or more crops simultaneously on the same piece of land, with sufficient overlap to include at least the vegetative growth stage (Gomez and Gomez, 1983). This approach offers a practical and sustainable means of improving land use efficiency, increasing farm income, and enhancing soil fertility, which together contribute to better yield and crop quality. Intercropping is widely adopted because it increases productivity per unit area and allows more efficient use of resources such as land, labour, time, light, water, and nutrients. It also helps reduce the incidence of pests, diseases, and weeds. Beyond agronomic benefits, intercropping provides socio-economic advantages by improving income stability, supporting better nutrition, and promoting ecological balance (Vandermeer, 1989).

Intercropping maintains soil cover for extended periods, often throughout the year, unlike single-crop systems. This continuous cover helps protect the soil from moisture loss and reduces the risk of erosion. Growing multiple crops together on the same land provides a sustainable strategy to diversify farm income, improve soil condition, make better use of water, maintain soil fertility, and minimize erosion, common problems in monocropping systems (Hoshikawa, 1991). This practice is widely followed in tropical regions, where climatic conditions support a range of crop combinations. Spices such as black pepper and cardamom, along with medicinal and aromatic crops like aloe vera and lemongrass, are commonly selected as intercrops due to their adaptability and high economic returns.

Farming practices such as intercropping, double cropping, and other mixed cropping systems are closely associated with sustainable agricultural production, as they promote efficient use of on-farm resources (NRC, 1993; Tolera, 2003). These approaches also help balance labour requirements across the year, since different crops have varying planting and harvesting periods. In addition, they can enhance productivity per unit area, especially under low external input conditions, because diverse crop combinations utilize soil nutrients and water more effectively (Kotschi *et al.*, 1986). Intercropping also modifies both the above-ground and below-ground growing environment, thereby influencing crop growth and development (Pulkrabek *et al.*, 2007).

Coconut

According to Subramanian *et al*. (2009), intercropping coconut with pineapple or banana can enhance coconut yield. Unlike annual crops, intercropping in coconut plantations does not necessarily reduce the productivity of the main crop. The intercrops should be chosen to utilize available natural resources efficiently while avoiding excessive competition with coconut. Although these crops may not compete for sunlight, they could compete for soil moisture and nutrients. However, if water and nutrients are provided according to the specific needs of each crop, coconut yield will not be negatively affected. Intercropping systems exhibit more complex interactions than monocropping or sequential cropping systems, as these interactions can vary greatly depending on the combination of crops for instance, overstorey crops with coffee and cocoa or mixtures of legumes and grasses (Allen *et al*., 1976). Beyond the additional income generated, intercropping also has a beneficial influence on coconut yield, contributing to an overall enhancement in the productivity of the entire farming system.

Glyricidia can be successfully grown as intercrop in coconut gardens in coastal sandy soil (where no other green manure crop can establish), and supply green manure continuously (Subramanian *et al*., 2000). The coconut growth was not affected by intercropping with glyricidia. Application of glyricidia prunings from the interspace of one hectare of coconut garden to the coconut palms could meet a major portion of nitrogen (88 per cent), part of phosphorus (27 per cent) and potassium (13 per cent) requirement of coconut palms.

Rubber

The findings indicated that nearly thirty years after the conversion of tropical rainforest into rubber monoculture, the soil experienced substantial degradation. This deterioration was reflected in weakened physical properties, poor structural stability, reduced moisture retention, unstable soil aggregates, nutrient depletion, and increased erosion. In contrast, rubber-based agroforestry systems, including both HTAs and HFAs, significantly enhanced soil quality within these plantations. When compared to monoculture systems, agroforestry practices led to notable improvements in key soil parameters. Total soil porosity, initial moisture content, mean weight diameter (MWD), and hydraulic conductivity (Ks) increased by approximately 13.3%, 54.7%, 31.5%, and 246.4%, respectively. Furthermore, essential nutrients such as carbon (C), nitrogen (N), phosphorus (P), calcium (Ca), and magnesium (Mg) showed average increases of 38.8%, 38.5%, 48.2%, 47.9%, and 31.4%, respectively, following the shift to agroforestry systems. Overall, the introduction of intercrops in rubber plantations improved both physical and chemical soil characteristics. The design and management of intercropping systems play a crucial role in enhancing long-term agricultural sustainability and environmental health (Chen *et al*., 2019).

Thus, integrating rubber cultivation with intercropping, or adopting rubber-based agroforestry systems, can serve as an effective approach for advancing sustainable agricultural practices and improving environmental stability in rubber plantations (Viswanathan and Shivakoti, 2008).

Oil palm

Intercropping in oil palm during the juvenile stage showed that the practice did not negatively influence the growth of the palms. Instead, the intercrops contributed substantial biomass, ranging from 0.5 to 17 t ha^{-1}, which could be utilized by the palms in later stages (Reddy *et al*., 2004). Cultivating okra as an intercrop in young oil palm plantations resulted in higher net returns compared to other vegetable intercrops. An assessment of soil nutrient status before and after the experiment, in both intercropped and non-intercropped plots, indicated that all nutrients except nitrogen increased in soils where intercrops were grown (Reddi *et al*., 2015).

Tea

Introducing trees, fruit crops, and other species into tea plantations can markedly enhance the above-ground conditions that support tea growth (Xianchen *et al*., 2020; Wang et al., 2018). The canopy formed by woody intercrops provides shade, while ground-covering herbs protect the soil surface, together helping to moderate temperature fluctuations. Intercropping with *Vulpia myuros* has been shown to lower summer soil temperature in a manner comparable to black plastic film and rice straw mulching (Xianchen *et al*., 2020). To reduce the negative effects of excessive light on tea plants, practices such as shade nets and intercropping systems are commonly adopted. Among these, intercropping stands out as a sustainable and efficient approach to managing light, as it helps maintain favourable light conditions for optimal tea plant growth.

While chemical and biological methods remain the primary approaches for pest control in tea plantations, intercropping offers an environmentally safe alternative. Rather than eliminating pests directly like chemical or botanical pesticides, intercropping works by suppressing or reducing pest incidence without causing environmental pollution (Chen *et al*., 2019; Chen *et al*., 2011). Compared with plantations managed using chemical pesticides, intercropping systems have been found to lower pest populations, enhance the presence of natural enemies, and improve tea quality, particularly by increasing aromatic compounds (Li *et al*., 2019). In addition, intercropping modifies the below-ground environment by improving soil nutrient status, moisture levels, and temperature regulation. It also helps reduce heavy metal accumulation while influencing soil enzyme activity and microbial composition. These changes promote higher enzyme activity and increase beneficial microbial populations, thereby enhancing nutrient cycling within the soil.

Conclusion

Intercropping is a smart approach that makes better use of available land and resources while improving overall farm productivity. By growing different crops together, farmers can harvest more from the same field, reduce risks from pests, diseases, and climate uncertainties, and maintain soil health. It also provides an additional source of income and ensures better stability compared to growing a single crop. Though it may require careful planning and a bit more management, the benefits of intercropping clearly balance the challenges. With proper crop combination and good farming practices, intercropping can play a key role in promoting sustainable agriculture, improving livelihood, and ensuring food security for the future.

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